RELAXATION AND EXPOSURE TO NATURE DURING LUNCH BREAKS: EFFECTS ON CORTISOL, PERCEIVED STRESS AND FATIGUE

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The stress hormone cortisol is reactive to changes in a person's experienced inner states and surroundings. There are plenty of studies showing that job stress and job demands increase cortisol secretion and affect the diurnal cortisol rhythm. Physiological measures have, however, rarely been used in organizational intervention studies. The aim of this study was to examine whether relaxation exercises and park walks during the lunch break affect cortisol secretion, perceived stress and fatigue in employees.

The data were collected in two randomized controlled trials (RCT) undertaken in spring and fall 2014. A total of 153 workers, of which 137 were females, participated in the study. Mean age of the participants was 47 years. The data were collected during four weeks (on Tuesdays and Thursdays), including a two-week intervention period. During the intervention period, subjects in the intervention groups engaged either in a relaxation exercise or a park walk for 15 minutes on each working days' lunch break (in total 10 days). Salivary cortisol was measured right after awakening, 30 minutes after awakening, and in the evening. Three cortisol indices (CARi, CDD and AUCg) were derived from these measurements. Stress and fatigue were measured with one-item SMS questionnaires: stress in the afternoon and fatigue in the morning and in the evening. Screening data for confounders (e.g. having an endocrine disease, alcohol use) and excluding non-respondents from the sample resulted in a sample of 77 subjects.

The results of analysis of variance for repeated measures showed that neither relaxation nor exposure to nature showed significant intervention effects on the cortisol variables, or perceived stress or fatigue. Seasonal effects were observed. Evening fatigue and AUCg levels were higher in fall than in spring. Contrary to expectations, correlations between cortisol and subjective variables were negative or nonsignificant. Clearest negative associations were observed between evening cortisol and evening fatigue, and between CDD and evening fatigue. Thus, the higher the level of perceived fatigue was in the evening, the lower the level of cortisol in the evening and the steeper the decrease in cortisol during the day were.

The two lunch break interventions were not effective in producing effects on cortisol, or perceived stress or fatigue. Power issue may have affected the results, so that the observed trends did not reach a level of significance. The negative relations between evening fatigue and corresponding cortisol variables (which may have different effects on stress and fatigue in special groups, such as burnout patients) and the seasonal variations on cortisol secretion should be taken into account when conducting further studies. It seems that longer or more intensive relaxation and exposure to nature interventions are needed to affect cortisol functioning.

Key words: cortisol, lunch break, relaxation, park walk, stress, fatigue, intervention

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Stressihormoni kortisoli on reaktiivinen ihmisen subjektiivisia tiloja ja ympäristöä koskeville muutoksille. Useissa aiemmissa tutkimuksissa on havaittu, että työstressi ja työn vaatimukset lisäävät kortisolin eritystä ja vaikuttavat sen vuorokausirytmiin. Fysiologisia mittauksia on kuitenkin vain harvoin käytetty työpaikoilla tehdyissä interventiotutkimuksissa. Tämän tutkimuksen tarkoituksena oli tutkia lounastauon aikaisen rentoutusharjoituksen ja puistokävelyn vaikutuksia kortisolin eritykseen, sekä koettuun stressiin ja väsymykseen työntekijöillä.

Tutkimus koostui kahdesta satunnaistetusta kontrollitutkimuksesta (RCT), joiden aineistot kerättiin kevään ja syksyn 2014 aikana. Yhteensä 153 työntekijää osallistui tutkimukseen. Tutkittavista 137 oli naisia, keski-ikä oli 47 vuotta. Aineistot kerättiin neljän viikon aikana, tiistaisin ja torstaisin. Interventiojakso kesti kaksi viikkoa. Interventiojakson aikana interventioryhmien tutkittavat tekivät rentoutusharjoituksen tai kävelivät puistossa 15 minuuttia jokaisella lounastauollaan, yhteensä kymmenenä päivänä. Syljen kortisoli mitattiin heti heräämisen jälkeen, puoli tuntia heräämisestä ja illalla. Kolme kortisoli-indeksiä (CARi, CDD ja AUCg) johdettiin näistä mittauksista. Koettua stressiä ja väsymystä mitattiin yksiosioisilla tekstiviestikyselyillä: stressiä iltapäivällä ja väsymystä aamulla sekä illalla. Datan seulominen häiriömuuttujien (esim. endokriinisten sairauksien ja alkoholinkäytön) osalta ja ns. non-respondenttien poistaminen analyyseista johti 77 tutkittavan otokseen.

Toistomittausten varianssianalyysien mukaan niin rentoutus kuin puistokävelykään eivät tuottaneet merkitseviä interventiovaikutuksia kortisoliin, koettuun stressiin tai väsymykseen. Tuloksissa havaittiin eroja vuodenaikaan nähden. Illalla koetun väsymyksen ja AUCg:n tasot olivat korkeampia syksyllä kuin keväällä. Korrelaatiot kortisolimuuttujien ja subjektiivisten muuttujien välillä olivat odotusten vastaisesti negatiivisia tai ei-merkitseviä. Selkeimmät negatiiviset yhteydet havaittiin illalla mitatun kortisolin ja illalla koetun väsymyksen, sekä CDD:n ja illalla koetun väsymyksen välillä. Toisin sanoen, mitä enemmän illalla koettiin väsymystä, sitä alhaisempi oli kortisolin taso illalla ja sitä jyrkempää oli kortisolin lasku aamutasosta iltaan.

Tutkitut kaksi lounastaukointerventiota eivät olleet vaikuttavia kortisolin, koetun stressin tai väsymyksen suhteen. Tilastollisen voiman vähyys saattoi vaikuttaa siihen, että havaitut trendit eivät saavuttaneet merkitsevää tasoa. Negatiiviset yhteydet illalla koetun väsymyksen ja siihen liittyvien kortisolimuuttujien välillä (joilla saattaa olla erilainen vaikutus stressiin ja väsymykseen erityisryhmissä, kuten burnout-potilailla) sekä kortisolin erityksen vuodenaikaiset vaihtelut tulisi ottaa huomioon tulevia tutkimuksia toteutettaessa. Selkeämpien muutosten aikaansaaminen kortisolin erityksessä saattaa vaatia pidempien tai intensiivisempien lounastaukointerventioiden toteuttamista.

Avainsanat: kortisoli, lounastauko, rentoutus, puistokävely, stressi, väsymys, interventio

INTRODUCTION

Lunch breaks as a recovery setting

In modern working life, workers have to face various challenging cognitive, emotional and social demands. To meet these demands, workers usually have to invest more of their personal resources (such as energy and attention) than they would otherwise do in their everyday life. Thus, their "required state" differs from their "actual state", depleting their resources (Zijlstra, Cropley, & Rydstedt, 2014). Accordingly, they need opportunities to refresh the depleted resources, that is, to recover.

Meijman and Mulder (1998) defined recovery as a process that allows strained psychobiological systems to return to a specific baseline level in a given period of time. If there is not enough time for recovery, or the recovery process is otherwise insufficient (for example due to rumination, see Brosschot, Gerin, & Thayer, 2006), to compensate for the personal effort devoted during working time, sustained load effects may occur. These effects may include, among other things, a negative emotional charge and an elevated activation of the autonomous nervous system. This tension response or stress reaction usually involves increased secretion of cortisol and adrenaline in the body (Meijman & Mulder, 1998).

Sonnentag and Fritz (2007) have studied four mechanisms that promote recovery during off-work time, namely psychological detachment from work, relaxation, mastery experiences and control. Out of these, especially psychological detachment from work during off-job time has been shown to have important relations to many health-related outcomes, such as well-being, decreased need for recovery and subjective ability to work (Sonnentag & Fritz, 2007, 2015; Tirkkonen & Kinnunen, 2013).

Although recovery from work has established its position as an important field of research in work and organizational psychology, there are not many studies focusing on within-working day processes, such as rest breaks (Sianoja, Kinnunen, de Bloom, & Korpela, 2015). Taking regular rest breaks during the workday is generally recommended both in practice as well as in research literature to counteract the demands of work and cumulative fatigue during working time (e.g. Tucker, 2003). Besides having the opportunity for rest during the working day, it also matters what happens during the rest break. For example, participating in low-effort activities and socializing during breaks instead of engaging in effortful activities (chores) increased both experienced and displayed positive emotions among instructors working at five cheerleading training camps (Trougakos, Beal, Green, & Weiss, 2008).

The most important opportunity for recovery during the working day is usually the lunch break, since it is commonly the longest within-workday break and is also guaranteed by legal rights, such as the European Working Time Directive (2003/88/EC). Lunch breaks take place on the level of mesorecovery (breaks which last from 10 minutes to about an hour) (Sluiter, Frings-Dresen, Meijman, & van der Beek, 2000). Lunch breaks' main function is to offer an opportunity to replenish the energy reserves of the worker's body by consuming food. Breaks may also create a situation in which benefiting from the mechanisms of recovery (e.g. detaching psychologically by leaving the workplace or relaxing by taking a nap) becomes possible.

As there is much less information about the effects of lunch breaks and other within-workday breaks on recovery and job stress than about the effects of out-of-work processes (Sianoja et al., 2015), more research is greatly needed. Research data about the immediate effects of exposure to nature on human physiology, specifically, is also relatively scarce (Bowler, Buyung-Ali, Knight, & Pullin, 2010). Previous studies of recovery during lunch breaks have also not compared different types of interventions to one another. So it is difficult to say how effective interventions focusing on relaxation, for example, are compared to other kinds of interventions (Sianoja et al., 2015). In the present study, a longitudinal design is used to examine the effects of two different 15-minute lunch break interventions: exposure to nature and relaxation.

In the present study, the effects of these two interventions on salivary cortisol, subjective stress and fatigue are examined both independently and in relation to one another, and compared to a control group. Because subjective self-report measures and the more objective (e.g. physiological) measures of job stress are prone to unique measurement biases, examining them together is recommended (Ganster, 2008). A 4-week design, with interventions implemented every working day during study weeks 2 and 3, enables reliably analyzing both the immediate and delayed effects with respect to baseline values before the intervention period. Separate data gathered during both the spring and fall of 2014 enables also examining the role of seasonal variation in the research questions.

Cortisol as a physiological stress marker and the role of different measures

There are various psychobiological mechanisms in the body that link environmental stressors and stress responses together. The hypothalamic-pituitary-adrenal (HPA) axis has received a large amount of research attention due to its mediating role between stress and health-related outcomes (McEwen, 1998; Nater, Skoluda, & Strahler, 2013). For example, higher cortisol concentrations (hypercortisolism) have been found among those with post-traumatic stress disorder, whereas lower cortisol responses to stressful situations (hypocortisolism) have been related with irritable bowel syndrome (Nater et al., 2013).

The HPA axis consists of the hypothalamus, the anterior lobe of the pituitary gland and the adrenal cortex (Nater et al., 2013). If an individual experiences high psychosocial stress (such as when giving a public speech or breaking up), the hypothalamus secretes corticotrophin-releasing hormone (CRH), which causes the pituitary gland to release adrenocorticotropic hormone (ACTH) into the bloodstream. ACTH, in turn, causes the adrenal cortex to secrete the stress hormone cortisol. The increase of cortisol levels in the bloodstream inhibits the further release of CRH and ACTH, and thus creates a negative feedback loop. If the stressful situation persists for long, however, the stress-responsive systems in the body (such as the HPA axis) are taken to their functional limits, which may lead to elevated levels of cortisol and other stress hormones (McEwen, 1998). This cumulative stress on the physiological level has been described as allostatic load by McEwen (1998).

Cortisol levels in the body typically follow a diurnal pattern (Nater et al., 2013). After awakening there is a rapid increase until 30 to 45 minutes, after which the levels decrease gradually towards the evening. The increase in cortisol secretion after waking up is called the cortisol awakening response (CAR) (Chida & Steptoe, 2009). Different types of CAR measures have been introduced. For example, the CARi (also named CARdelta in the research literature, such as in Krajewski, Sauerland, & Wieland, 2011) usually refers to the difference between the cortisol peak level (measured at 30 or 45 minutes after awakening) and the baseline level of cortisol right after awakening. The CARauc, in turn, refers to the overall levels of cortisol secretion in the first hour after awakening, measured usually by integrating the measures of the area under the curve from repeated measures (Chida & Steptoe, 2009; Pruessner, Kirschbaum, Meinlschmid, & Hellhammer, 2003).

The different measures of CAR are linked to different health- and well-being-related outcomes, as shown in a review article consisting of 147 studies reported in 62 articles (Chida & Steptoe, 2009). For example, job stress and general life stress were related to higher CARi, whereas fatigue, burnout and exhaustion were related to lower CARi. The CARauc had a positive relationship to general life stress. The relationship between CARi and job stress persisted when only high quality studies were taken into account in the review. Since CARauc was not related to job stress, burnout or fatigue, it seems that CARi is a more relevant measure of cortisol in work and organizational contexts than CARauc (Chida & Steptoe, 2009).

The decline of cortisol levels during the day (CDD, also named decline to evening or simply decline) has received less research attention than CAR in psychophysiological studies. CDD can be measured as the difference between the peak level (measured 30 or 45 minutes after awakening) and the evening cortisol level (measured in the evening before going to bed) (e.g. Hansen, Hogh, & Persson, 2011). It is also possible to use the maximum morning concentration (i.e. choosing the highest of morning samples) and calculate the difference with the evening cortisol level (e.g. Karlson, Eek, Hansen, Garde, & Ørbæk, 2011).

If a stressor persists for long periods of time, the physiological stress systems can be in a state of prolonged activation, which hinders recovery (McEwen, 1998). Thus, a flat CDD (absence of a decline in cortisol levels towards the evening) may reflect insufficient recovery from persisting job stress. In the literature, less expressed affection (Floyd, 2006) and high job demands (Karlson et al., 2011), but also high job control (Steptoe, Cropley, Griffith, & Kirschbaum, 2000) have been associated with flattened CDD (a lower difference between the peak cortisol level minus the evening level). In the study by Karlson et al. (2011), also low job rewards and more symptoms of mental distress were related to flattened CDD in men, whereas in women these relationships were in the opposite direction.

Among female health care workers, decision authority (control), physical functioning, general health, vitality and active coping were positively related to a steeper CDD in unadjusted regression analyses (Harris, Ursin, Murison, & Eriksen, 2007). Only the relationship between decision authority and CDD remained significant when a regression model adjusted for correlating covariates (age and coffee use) was used (Harris et al., 2007). In many of the studies where CDD has been measured, cortisol samples were collected only for one or two days, which limits the statistical power to observe within-subject effects (Kudielka, Gierens, Hellhammer, Wust, & Schlotz, 2012). Therefore, the results should be interpreted with caution.

Some studies have applied other measures of diurnal cortisol slopes than CDD (e.g. using the awakening cortisol sample as a base measure for decline during the day instead of the 30-45 minutes after awakening sample). In these studies, high perceived stress (Lovell, Moss, &

Metherell, 2011, only women in the sample), high effort-reward imbalance (Liao, Brunner, & Kumari, 2013), sampling on a working day and less physical activity (Vreeburg et al., 2009), lower income and lower education (Cohen et al., 2006), and depressed affect (Decker & Aggott, 2013), for instance, have been associated with flattened cortisol slopes. Flat cortisol diurnal profiles were also related to more fatigue in most of the relevant studies (total n = 19) included in a review by Powell, Liossi, Moss-Morris and Schlotz (2013). Gender differences have been found in some studies as well (e.g. Vreeburg et al., 2009). Altogether, although there are some inconsistencies concerning the results of studies that have measured CDD, it seems that flat cortisol diurnal profiles are in most cases related to stressful states and environments.

The HPA axis and its end product cortisol are particularly responsive to daily psychosocial stress (Nater et al., 2013), and low evening cortisol values usually reflect better physiological recovery (McEwen, 1998). Therefore, in intervention studies wherein also the short-term day-level cortisol fluctuations are of interest, it is reasonable to investigate the evening values also separately. In a study by Krajewski et al. (2011), there was a minor decrease in the bedtime cortisol values of the group that implemented progressive muscle relaxation exercises during lunch break, in comparison with the control group. In other studies, higher perceived stress (Lovell et al., 2011, only women in the sample), lower income and lower education (Cohen et al., 2006) and lower decision authority (Harris et al., 2007), for example, have been associated with higher evening cortisol levels.

The total cortisol output (AUCg) reflects the overall level of unbound cortisol that is secreted during the day, from morning to evening (Adam & Kumari, 2009). It can be calculated as area under the curve, which enables controlling the effects of individually differing measurement times (e.g. Pruessner et al., 2003). Elevated overall cortisol levels (hypercortisolism) in the body reflect the activation of the HPA axis, which is initiated by psychosocial stressors (McEwen, 1998). Prolonged overconcentration of cortisol can be detrimental to the immune system and health (Meijman & Mulder, 1998; Nater et al., 2013). AUCg provides unique information about the overall level of cortisol across the whole day, but diurnal variation is neglected in this measure (Adam & Kumari, 2009).

Higher positive affect has been associated with a lower total cortisol output in many studies (Dockray & Steptoe, 2010). Consistently, among 26 white-collar workers, lower psychological well-being was related to higher total cortisol secretion (Lindfors & Lundberg, 2002). Higher perceived stress has also previously been positively related to mean diurnal output, a different (but not time-controlled) measure of cortisol secretion across the whole day (Lovell et al., 2011). In the review by Powell et al. (2013), in turn, a higher total cortisol output was related to higher fatigue in only one of the six studies that measured this association. In the other studies, no relation between total cortisol output (AUCg) and fatigue was found (Powell et al., 2013).

Effects of relaxation techniques and exposure to nature on cortisol and perceived well-being

As relaxation is an important mechanism of recovery (Sonnentag & Fritz, 2007), improving relaxation should be effective for improving recovery also on physiological level. Interventions that aim to improve relaxation often combine relaxation therapy, which focuses on releasing muscle tension consciously and in a controlled way, with meditation or deep-breathing exercises (Richardson & Rothstein, 2008).

Methods that improve relaxation have been previously demonstrated to affect cortisol secretion. For example, Krajewski et al. (2011) studied 14 call center agents who participated either in progressive muscle relaxation (PMR) implemented in a silent room, or in a small talk group during their lunch break. The interventions lasted for 20 minutes each, and the intervention period lasted for six months in total. During the intervention period, the subjects participated in the PMR or small talk group every working day. There was a significant decline in the intervention group's post-lunchtime and bedtime cortisol levels one week after the start of the intervention. Thus, PMR seemed to reduce immediate stress. A reduced CARdelta (calculated as the difference between saliva cortisol levels 30 minutes after awakening and saliva cortisol levels right after awakening), in turn, was observed only 5-6 months after the start of the intervention period, and not right away (Krajewski et al., 2011). Consistently, Pawlow and Jones (2005) found that abbreviated (20-25 min) progressive relaxation reduced immediate post-intervention salivary cortisol levels among 41 undergraduate students, whereas there was no significant change among controls (n = 14) who sat quietly in the laboratory for 25 minutes.

In a meta-analysis by Richardson and Rothstein (2008) consisting of 36 experimental studies that represented 55 interventions, relaxation interventions (n = 17) were found to be generally effective for different health-related and organizational outcomes (such as stress or productivity), although effect sizes for cognitive-behavioral interventions (n = 7) were significantly larger. One possible explanation is that none of the cognitive-behavioral interventions were measured against physiological outcomes, whereas five of the relaxation interventions were. The five relaxation interventions did not have a significant effect on physiological measures such as blood pressure or pulse. None of these five studies, however, measured cortisol as an outcome (Richardson & Rothstein, 2008).

Natural environments are commonly seen as promoters for health and well-being (Thompson & Aspinall, 2011). For example, in a Finnish study, interacting with nature during free-time was associated with lower need for recovery (Korpela & Kinnunen, 2011). This effect was mediated by time spent in exercise and being outdoors, relaxation and life satisfaction. Research surveys on the effects of exposure to nature for physiological measures, however, have been mixed. In a meta-analysis by Bowler et al. (2010), although exposure to a natural environment (in comparison to a more synthetic environment) had a positive effect on self-reported measures of emotions, the effects on physiological variables, such as blood pressure and cortisol concentrations, were less clear, but less data was available as well (Bowler et al., 2010).

Brown, Barton, Pretty and Gladwell (2014) examined the effects of physical activity (namely, walking) during lunchtime. They used two walking groups (nature/park and built environment), and a control group. The walks during lunch breaks lasted for 20 minutes each and were carried out two times a week, for a total of eight weeks. Data were collected at the beginning of the intervention and at the end. No differences in resting heart rate (HR) or HR variability were found among the 73 participants. However, the adherence rate was low in the study (42-43% in the walking groups), therefore the null results need to be interpreted with caution. Self-reported mental health increased compared to baseline in the nature walk group, whereas no change was found in the built environment walk or control group (Brown et al., 2014).

In a recent study among 77 mostly middle-aged participants (6 men), salivary cortisol levels decreased similarly after viewing landscapes and walking in either an urban park, an urban woodland or a built-up area in the city (Tyrväinen et al., 2014). Decreases in cortisol levels have been found in Japanese studies, however, after visiting a forest or a forested park, when compared to being in a city area (Lee et al., 2011). More studies are needed to determine if exposure to nature is related to subsequent decreased cortisol concentrations in the body.

Research questions and hypotheses

In this study, I have three aims. First, I focus on how participating in a lunch break intervention (relaxation, exposure to nature, control) affects the levels of cortisol secretion (Research question 1). Both relaxation and exposure to nature have been previously shown to improve well-being and recovery (Korpela & Kinnunen, 2011; Richardson & Rothstein, 2008), although data for the effects of nature interventions is partially mixed (Bowler et al., 2010) and these studies do not concern lunch breaks. An increased cortisol awakening response can reflect a reactive response to expected stress (McEwen, 1998). I hypothesize that both lunch break activities, relaxation and exposure to nature, will diminish the cortisol awakening response (CARi, *Hypothesis 1a*). Similarly, as decreases in daytime or evening cortisol levels have been reported for both relaxation interventions (Krajewski et al., 2011; Pawlow & Jones, 2005) and exposure to nature interventions (Lee et al., 2011), I hypothesize that both relaxation and exposure to nature interventions will steepen the cortisol decline during the day (CDD, *Hypothesis 1b*), reduce the evening cortisol level (*Hypothesis 1c*) and decrease the total free cortisol output (AUCg, *Hypothesis 1d*).

Second, I examine how participating in a lunch break intervention affects the measures of subjective stress (Research question 2). Both relaxation and exposure to nature interventions have shown positive effects for self-reported measures of well-being (Bowler et al., 2010; Korpela & Kinnunen, 2011; Richardson & Rothstein, 2008). Therefore, I hypothesize that both interventions will have positive effects for perceived stress and fatigue, resulting in lower stress at the end of the work day (*Hypothesis 2a*) and lower fatigue in the evening (*Hypothesis 2b*) and in the morning (*Hypothesis 2c*).

Third, I study how the four cortisol measures (CARi, CDD, evening cortisol level and AUCg) relate to measures of self-reported stress and fatigue (Research question 3). Relations between cortisol measures and subjective stress and fatigue have been described in numerous articles (e.g. Chida & Steptoe, 2009; Liao et al., 2013; Lovell et al., 2011; Powell et al., 2013). Based on previous findings, I hypothesize that higher cortisol levels right after awakening and 30 minutes after awakening are related to higher fatigue in the morning (*Hypotheses 3a-b*), that higher evening cortisol levels are related to higher fatigue in the evening (*Hypothesis 3c*), that a lower CARi is related to higher fatigue in the morning (*Hypothesis 3d*), that a flatter CDD is related to higher stress at the end of the working day and to higher fatigue in the evening (*Hypotheses 3e-f*), and that a higher AUCg is related to higher stress at the end of the working day and to higher fatigue in the evening (*Hypotheses 3g-h*).

METHODS

Participants

The sample in this study consisted of 153 Finnish employees. The employees were recruited from seven different organizations: minimum requirement for inclusion was that each organization had to have at least six people who were willing to participate in the study. Within each organization, the subjects were randomly assigned to either relaxation group, exposure to nature group or control group. Initial sample sizes were 46 for the relaxation group, 51 for the exposure to nature group and 56 for the control group (see Table 1). For the two largest organizations, units working in different locations were randomly split, so that each unit participated in the study either during spring or during fall. Thus, seven organizations participated in the study in spring and three organizations participated in fall. Adherence was high, with 76 to 96 percent of the subjects being involved in relaxation or park walking on a daily level during the two intervention weeks. Three fourths (76%) of the subjects engaged at least eight times (out of ten) in relaxation or park walking during their lunch break across the intervention period (Figure 1).

Mean age of the subjects in the initial sample was 47.4 years, ranging from 25 to 62 years (Table 1). Nine out of ten of the subjects were women. Over half of the subjects had children living in their household. Almost two thirds of the subjects had an academic degree, and 40% had a Master's degree. Most of the subjects worked either in the public sector or in education (Table 1).

Due to data cleaning and missing saliva samples, the sample used for cortisol analyses and subjective measures analyses differed from the initial sample (see Figure 2 in more detail). The cortisol sample consisted of 60 subjects (20 for the relaxation group, 17 for the exposure to nature group and 23 for the control group) (Table 1). The subjective measures sample consisted of 136 subjects. There were no significant differences between the cortisol sample and the initial sample or between the subjective measures sample and the initial sample concerning background variables (Table 1).

TABLE 1. Characteristics of the sample used in this study and significances (*p*) of X^2-tests (and *t*-tests for age) compared to the initial sample. Cortisol sample = the sample of subjects which was applied for the cortisol analyses (used as a whole for the evening cortisol) (See Figure 2), Subjective sample = the sample of subjects which was applied for the subjective measures analyses (used as a whole for fatigue in the morning).

	Initial sample	Cortisol sample	*p*	Subjective sample	*p*
n (total)	153	60		136	
n (relaxation group)	46	20	0.74	39	0.85
n (exposure to nature group)	51	17	0.61	46	0.95
n (control group)	56	23	0.87	51	0.92
Age (years)	47.4	47.0	0.77	47.6	0.84
% women	90	87	0.89	89	0.97
% living alone	12	18	0.40	12	1.00
% cohabiting without children	33	36	0.77	32	0.94
% living with children	55	46	0.54	56	0.96
% Bachelor's degree or higher	62	63	0.92	60	0.88
% supervisor positions	12	10	0.73	13	0.86
% working in public sector	48	45	0.83	47	0.95
% working in education	29	37	0.46	32	0.77
% working in other sectors	23	18	0.56	21	0.80

Interventions

In this study, a short, self-practicable relaxation method developed by Tuomisto (1997) was used for the relaxation intervention group. The relaxation consisted of progressive muscle relaxation, deep breathing and also mindfulness meditation, specifically acceptance of experiences. Each session was implemented on every lunch break during the intervention period (study weeks 2-3, see Figure 1). Subjects in the relaxation group were given an intensive one and a half-hour training before the beginning of the study, where they had the chance to learn about the method and practice it at least once. The training was carried out by psychologists and/or trained psychology undergraduates.

For the exposure to nature intervention group, a 15-minute exposure to nature was implemented in a nearby park. Each walk was implemented on every lunch break during the intervention period (study weeks 2-3, see Figure 1). Subjects in the exposure to nature group were given a one-hour training, during which an environmental psychologist and/or a trained psychology undergraduate student walked a pre-determined route with the subjects. The subjects were instructed to walk the route in a comfortable pace and to pay attention to the elements of nature, such as trees

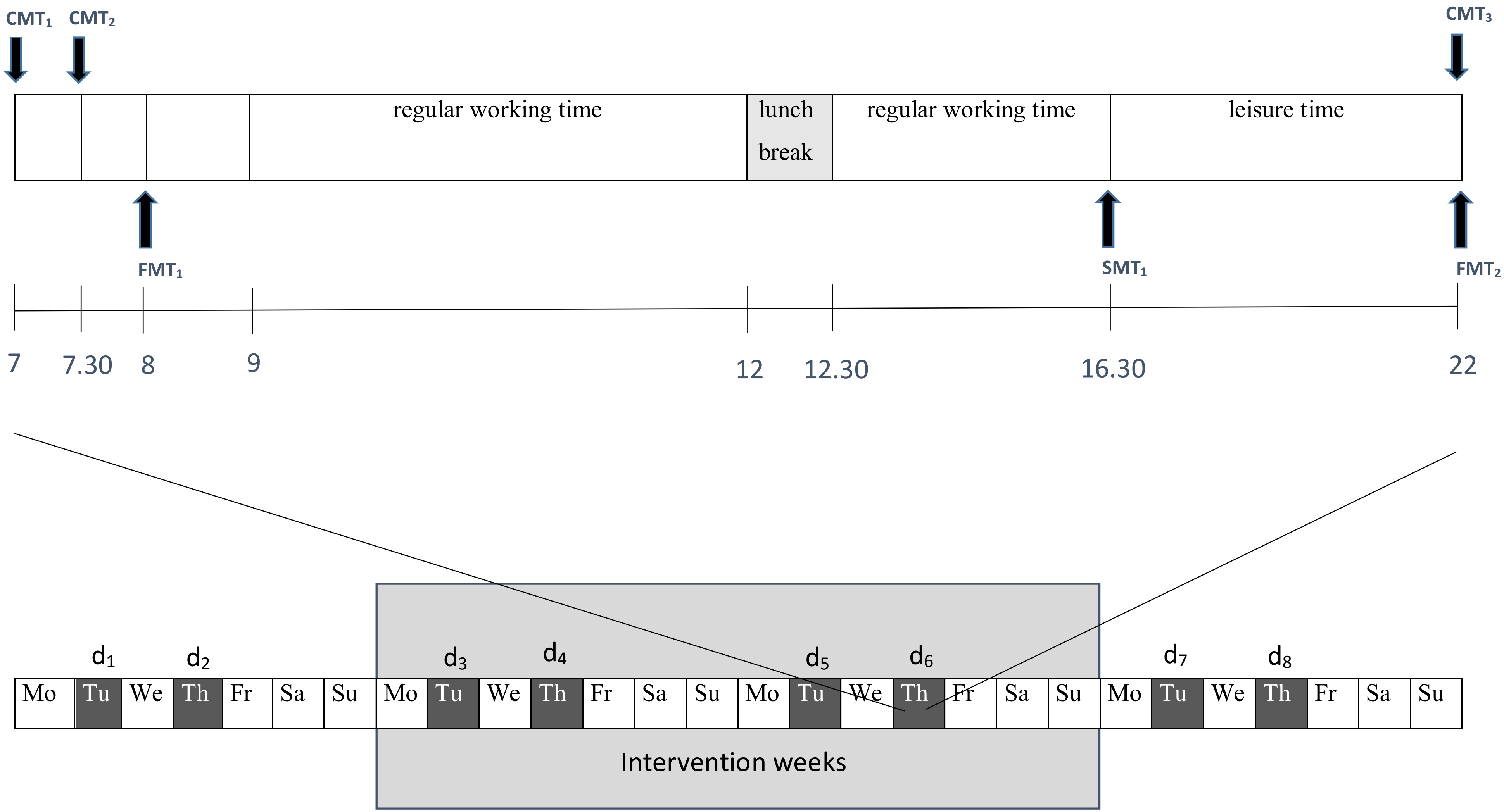

FIGURE 1. Time schedule of the experiment. ($CMT_{1\text{-}3}$ = cortisol measurement time, SMT_1 = subjective stress measurement time, $FMT_{1\text{-}2}$ = fatigue measurement time, $d_{1\text{-}8}$ = measurement day). Interventions (15 min) were carried out every working day during the lunch break in study weeks 2 and 3. Those in the control group spent their lunch break as usual. An illustrative timeline for a normal measurement day is shown in the upper part of the figure.

and other plants. No talking was allowed during the walk, since socializing has been previously shown to have an impact on recovery during breaks (see Trougakos, Hideg, Cheng, & Beal, 2014, for an example). The walking routes were determined based on earlier inspections near each participant's workplace, so that they could include as many natural aspects as possible. The control group spent their lunch break as usual during the intervention period.

Procedure and measures: Cleaning cortisol data and calculating measures

Each subject collected salivary samples (Salivette swabs) three times during each of the eight measurement days ($d_{1\text{-}8}$): right away after awakening, 30 minutes after awakening and in the evening before going to bed (see Figure 1). The subjects were instructed to refrain from exercising, eating, drinking, smoking or brushing teeth within 30 minutes before taking the sample, in order to minimize the number of confounded samples (see Kudielka et al., 2012). Subjects stored the samples in their own refrigerators, and the researchers gathered the samples at the subjects' work places twice across the study. The saliva samples were analyzed for cortisol concentrations by the Finnish Institute of Occupational Health's physiological laboratory.

Perceived stress was measured at the end of the workday on each measurement day (Figure 1), using a one-item scale which was inspired by a Finnish validation study (Elo, Leppänen, & Jahkola, 2003). The subjects responded to an SMS that was sent to them ("Right now, at the end of my work day, I feel stressed and tense") on a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree). *Perceived fatigue* was measured two times on each measurement day, once in the morning and once in the evening (Figure 1). A validated one-item questionnaire by Van Hooff, Geurts, Kompier, and Taris (2007) was applied. The subjects responded on a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree) to an SMS that was sent to them ("Right now, this morning/evening, I feel fatigued").

Several methodological considerations, such as dealing with inaccurate sampling times and potential covariates, need to be taken into account when performing statistical analyses on cortisol data (Stalder et al., 2016). The design in this study had eight measurement days and three measurement times per day for cortisol data (see Figure 1), therefore there were 24 cortisol measurements for each subject. Twelve percent of the cortisol values were missing for the whole cortisol data (see Figure 2). Cortisol values 3 standard deviations beyond the mean for each measurement time were considered outliers and were removed from the data. The cleaning for outliers was implemented separately for the spring data and for the fall data to keep the effects of potential seasonal variation in the data (Persson et al., 2008). As there were still some clear outliers left in the data that could have biased the analyses (for example a cortisol value of 69.068 nmol/l for the evening of measurement day 6, Fall data), the data were scanned once more and values that were 3 standard deviations beyond the mean were removed, again separately for the spring and the fall data. Overall, 4% of the cortisol values were removed as outliers (see Figure 2).

Next, 117 (3.2%) cortisol samples turned out to be confounded because of drinking, eating, smoking, exercising or brushing teeth within 30 minutes before collecting the sample and were excluded from the study. Samples which were confounded because the subject took medication within 30 minutes before taking the sample were also removed. Having an endocrine disease, such as hypothyroidism or diabetes, is a common exclusion criterion in cortisol studies, since those subjects usually have a divergent endocrinal functioning of their body (Adam & Kumari, 2009). Thus, subjects who had an endocrine disease (n = 21) were removed from the cortisol analyses, but not from the subjective measures analyses. Those subjects who had a psychiatric disease and took medication for it (n = 4) were also removed from the cortisol analyses (but not from the subjective measures analyses), since it can be assumed that they took the medications on a regular basis, which might have a notable impact on their HPA axis functioning (Kudielka et al., 2012). Overall, a further 16% of the cortisol samples were removed because of these exclusion criteria (see Figure 2).

Cortisol awakening response (CAR) is a measure that is highly sensitive to inaccurate measurement times (Stalder et al., 2016). For example, delaying the collection of the first morning cortisol sample (after awakening) by more than 15 minutes results in false-low estimates of the CAR and false-high estimates of the first sample (Stalder et al., 2016). In this study, cortisol samples for the morning that were not taken between 0 to 10 minutes after awakening (n = 60) were removed, to prevent inaccurate sample timing from affecting the results. The morning peak level of cortisol is typically between 30 and 45 minutes after awakening, with moderate variation based on gender (Wüst et al., 2000). Thus, values for the 30 minutes after awakening sample were also removed if they were not taken between 25 to 50 minutes after awakening (n = 38). Two evening cortisol values were also removed because the subjects reported strange measurement times (9.50 and 13.00, respectively). Overall, a further 2.7% of the cortisol samples were removed due to inaccurate sampling times (see Figure 2).

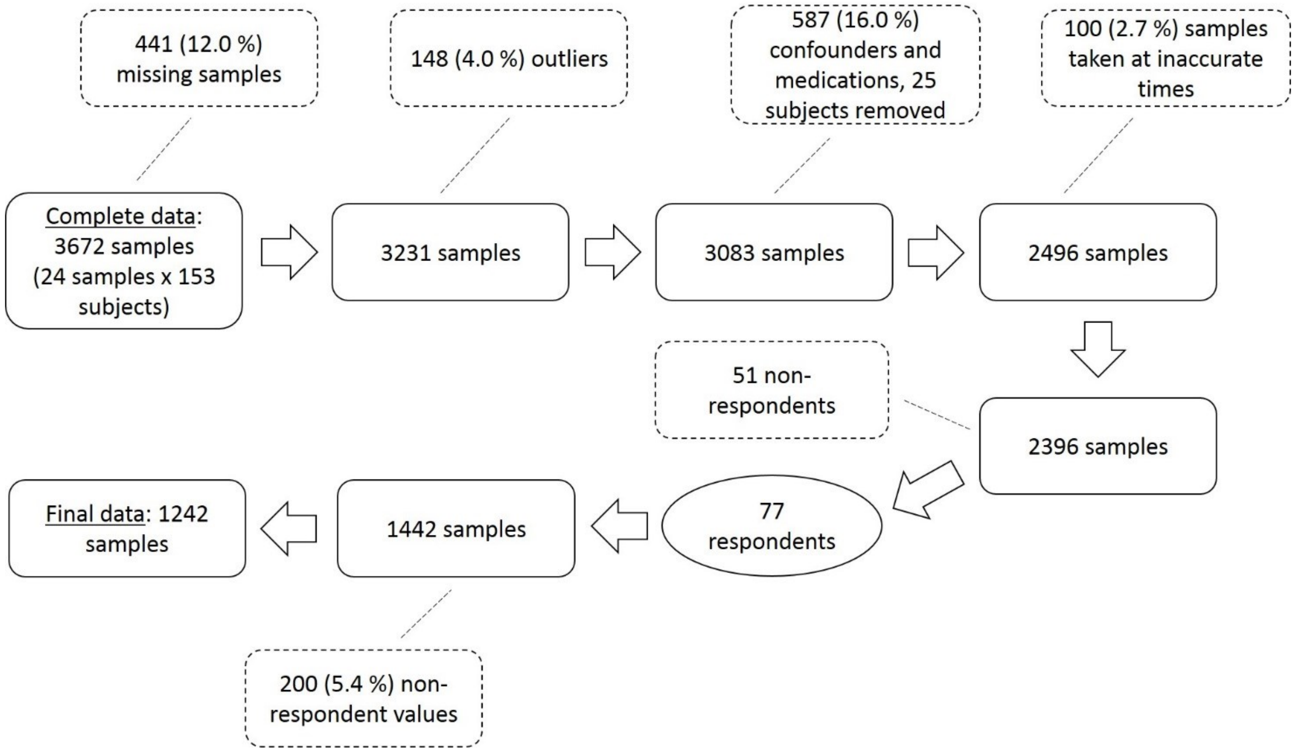

FIGURE 2. Data cleaning procedure for the cortisol data.

After removing confounded data, new variables were created for the three cortisol measurements (morning, 30 minutes after waking up and evening) by taking the mean of each study week's (weeks 1 - 4) two values (Figure 3). If only one of a specific week's values was missing, the other value served as the mean of that week. If both values were missing for a specific week, the value was coded as missing. Since the main interest in this study was to observe general patterns in the intervention weeks compared to pre- and post-intervention measurements (instead of momentary fluctuations), the two intervention weeks were also averaged with a similar procedure as before (Figure 3). Thus, each participant had 3 x 3 individual cortisol values (one value for the pre-intervention period, intervention period and post-intervention period for each measure). New variables were created in a similar way for perceived stress (measured at the end of the working day, 1 x 3 values) and fatigue (measured in the morning and in the evening, 2 x 3 values).

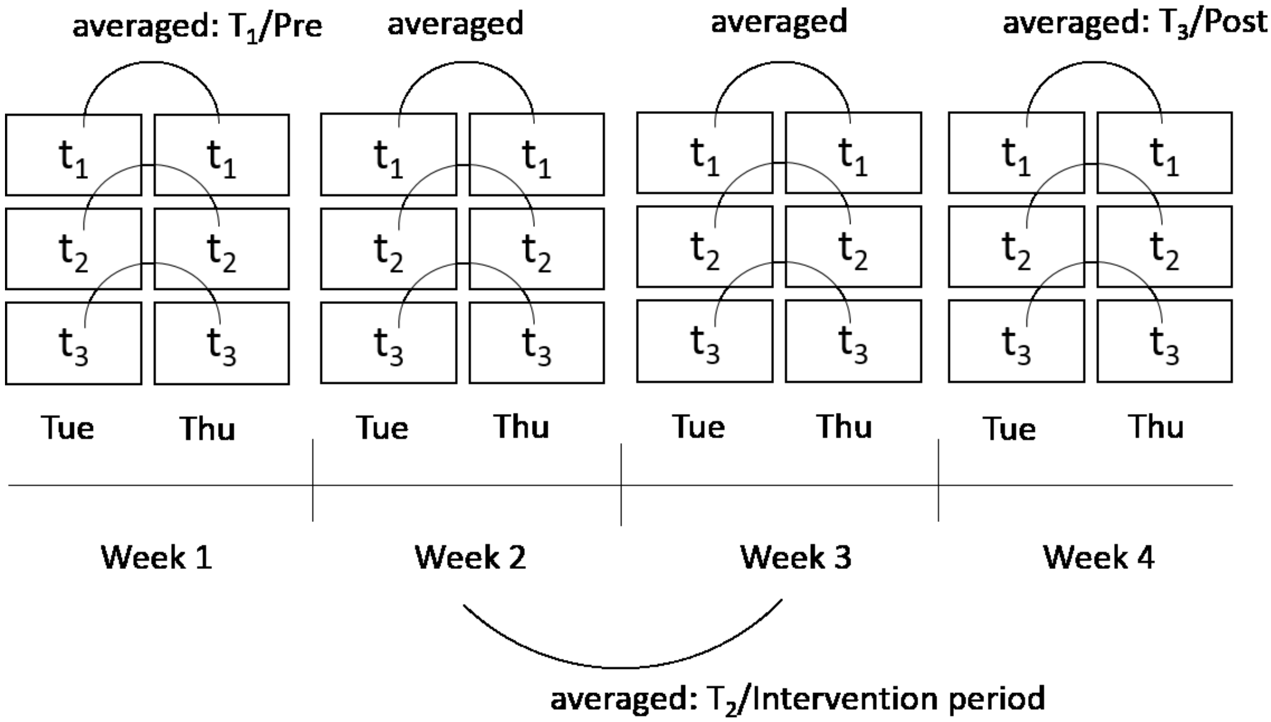

FIGURE 3. Cortisol values for each subject were first averaged as weekly values. Values for each study week were averaged separately. Then, values for week 2 and week 3 were averaged again as values during the intervention. $t_{1\text{-}3}$ = cortisol measurement time on each measurement day. $T_{1\text{-}3}$ = pre-, intervention period and post-measures.

Deviations from typical cortisol functioning, such as flat profiles, are often observed in cortisol studies. These deviations may relate to health problems (Nater et al., 2013) or problems with participant adherence (Stalder et al., 2016), for example. In this study, the cortisol analyses were focused on respondents, meaning those subjects who exhibited the typical pattern of cortisol awakening response characterized by a notable rise in cortisol concentrations from the first morning measure to the 30 minutes after awakening measure (Chida & Steptoe, 2009; Miller, Plessow, Kirschbaum, & Stalder, 2013).

In this study, a conservative criterion value of 2.5 nmol/l between the 30 minutes after the awakening measure and the first morning measure (CAR) was chosen to distinguish between respondents and non-respondents (Wüst et al., 2000). If a subject had a difference lower than 2.5 nmol/l between the 30 minutes after awakening measure and the first morning measure for more than one of the four study weeks (in averaged values), the subject was classified as a non-respondent. Otherwise, the subject was classified as a respondent. Of the subjects remaining in the sample, 77 people were classified as respondents (see Figure 2). If a respondent had non-respondent values (CAR lower than 2.5 nmol/l) for a measurement day ($d_{1\text{-}8}$), the first morning cortisol sample and 30 minutes after awakening sample for that day were removed from the cortisol analyses. Two hundred non-respondent cortisol values for respondents were thus removed (see Figure 2). The final cortisol data consisted of 1242 samples in 77 respondents (see Figure 2).

Since the distributions for the cortisol measures were positively skewed, a logarithm transformation (new x = ln (x)) was used as recommended by Tabachnick and Fidell (2013). Values for the outcome cortisol variables were formulated based on the previously derived, transformed cortisol values (see Figure 3). *Cortisol awakening response, CARi,* for each time point (1-3) was calculated as t2 minus t1 (Chida & Steptoe, 2009). *Cortisol decline* during the day, *CDD*, for each time point (1-3) was calculated as t3 minus t2 (see Hansen et al., 2011).

Total free cortisol output, AUCg, for each time point (1-3) was calculated as area under the curve with respect to the ground, as recommended by Pruessner et al. (2003, formula 2). The formula which was used to calculate the total free cortisol output was thus $AUCg = (m2 + m1) * \Delta t12 / 2 + (m2 + m3) * \Delta t23 / 2$, where m1, m2 and m3 are the total cortisol values for each cortisol measurement time 1,2 and 3, Δt12 is the interval between measures t1 and t2, and Δt23 is the interval between measures t2 and t3. Δt12 and Δt23 were calculated in minutes (Pruessner et al., 2003).

Analyzing the data: Control variables and statistical models

In the statistical analyses, analysis of variance (ANOVA) for repeated measures was applied for research questions 1 and 2. Because gender has shown to have an important influence on cortisol (e.g. Vreeburg et al., 2009), especially for the derived cortisol measures, gender was used as a control variable in all of the statistical analyses of this study. Persson et al. (2008) proposed that seasonal effects should be taken into account when conducting longitudinal designs such as interventions, since they may significantly modify existing effects even if the diurnal effects in the data are usually stronger. Thus, season was also used as a control variable in all of the statistical analyses. In this study, the number of control variables was kept to a bare minimum as recommended by Becker (2005). Thus, no other control variables were introduced to the models, since no prominent theoretical reasons were found for the inclusion of other possible variables (e.g. socioeconomic status, age).

Seven separate ANOVA models (for each hypothesis 1a-d and 2a-c) were then tested. Each outcome variable was entered as a dependent variable in the respective model. Time (three levels) was entered as a within-subject factor and study group (three levels) was entered as a between-subject factor. Gender and season were entered as covariates, as described above. First, for each model, the sphericity assumption was tested using the Mauchly's sphericity test. If the assumption was violated, a Greenhouse-Geisser estimate was applied. Means and main effects for all the group, time and interaction (group x time) variables were examined. *T*-tests and graph examinations were applied for the post-hoc tests. *P* levels below .05 were considered statistically significant both for the main effects and for the post-hoc tests.

For hypotheses 3a-h, partial correlations between the averaged (and transformed) cortisol and subjective stress values (3 time points for each hypothesis 3a-f) were examined separately. Gender and season were entered as covariates, and *p* values below .05 were considered statistically significant, as previously.

RESULTS

Testing the intervention effects on cortisol

Concerning hypothesis 1a, the mean CARi levels for each study group ranged from 11.39 to 18.91 nmol/l across the study period (SD's from 5.38 to 9.71, Figure 4). The interaction effect between the study group and measurement time was not statistically significant ($F(4, 88) = 0.646$, $p = .631$) (Table 2). The study group and the measurement time did not have statistically significant main effects on CARi either (Table 2).

Regarding hypothesis 1b, the mean CDD levels for each study group ranged from -23.17 to -32.11 nmol/l across the study period (SD's from 9.11 to 19.25, Figure 4, a higher negative value means a steeper decrease in cortisol from morning to evening). The interaction effect between the study group and measurement time was not statistically significant ($F(4, 90) = 0.767$, $p = 0.549$) (Table 2). There was a significant group effect for CDD ($F(2, 44) = 3.739$, $p = .032 < .05$). Post hoc –tests (*t*-tests) revealed a marginally significant effect for the week before the intervention between the relaxation group and the control group ($t(43) = -2.017$, $p = .050 < .10$). The relaxation group had a steeper CDD in the week before the intervention than the control group ($\bar{x}_{\text{Relaxation}} = -23.78$ nmol/l, $\bar{x}_{\text{Control}} = -23.17$ nmol/l, $\bar{x}_{\text{Relaxation}} = -2.15$, $\bar{x}_{\text{Control}} = -1.69$ after logarithm transformations).

Concerning hypothesis 1c, the mean levels of cortisol in the evening for each study group ranged from 3.42 to 5.29 nmol/l across the study period (SD's from 1.63 to 6.69, Figure 4). The interaction effect between the study group and measurement time was not statistically significant ($F(4, 112) = 1.546$, $p = 0.203$) (Table 2). There was a marginally significant interaction effect between measurement time and season for the evening cortisol level ($F(1, 55) = 3.126$, $p = .083 < .10$). During spring, the evening cortisol values seemed to increase during and after the intervention for the relaxation group and for the control group, whereas during fall, the evening cortisol values seemed to decrease for the exposure to nature group and for the control group (Appendix).

Regarding hypothesis 1d, the mean AUCg levels for each study group ranged from 15231.15 nmol/(l*min) to 18350.09 nmol/(l*min) across the study period (SD's from 4506.30 to 7449.01, Figure 4). The interaction effect between the study group and measurement time was not statistically significant ($F(4, 70) = 1.650$, $p = .182$) (Table 2). There was a marginally significant interaction effect between measurement time and season for the AUCg ($F(1, 34) = 4.007$, $p = .053 < .10$). The AUCg levels during fall seemed to be slightly higher than the levels during spring, and while during spring there was generally a slight increase in AUCg values across the study for all groups, during fall the control group's values seemed to decrease and the relaxation group's values seemed to increase during the intervention period (Appendix).

Overall, the interactions effects between the study group and measurement time ($T_{1\text{-}3}$) were not significant for the four cortisol measures (CARi, CDD, cortisol in the evening or AUCg). Thus, participating in the relaxation or exposure to nature interventions did not significantly affect any of the cortisol measures. Interactions effects between time and season (spring/fall) were observed for cortisol in the evening and AUCg.

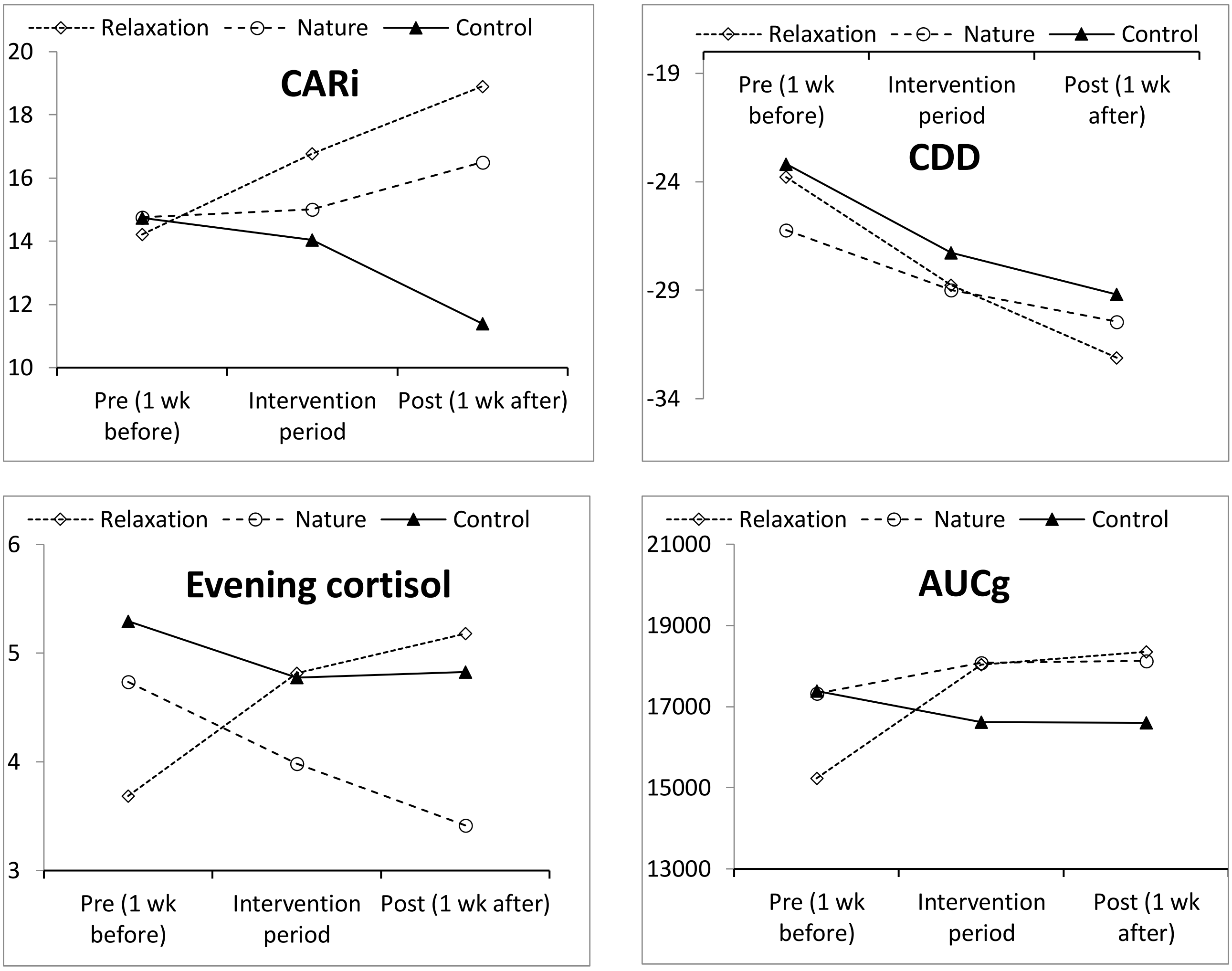

FIGURE 4. The group means for each cortisol variable before, during and after the intervention period (see Figure 1). Non-transformed values of the cortisol measures were used in the figure. Units in nmol/l for CARi, CDD and evening cortisol and in nmol/(l*min) for AUCg.

Testing the intervention effects on perceived stress and fatigue

Concerning hypothesis 2a, the mean stress levels for each study group ranged from 3.49 to 4.11 on a scale of 1 to 7 across the study period (SD's from 1.20 to 1.71, Figure 5). The interaction effect between the study group and measurement time was not statistically significant ($F(4, 244) = 1.110$, $p = .350$) (Table 2). The study group and the measurement time did not have any statistically significant independent effects on stress (Table 2).

Concerning hypothesis 2b, the mean levels of fatigue in the evening for each group ranged from 4.65 to 5.03 on a scale of 1 to 7 across the study period (SD's from 1.31 to 1.64, Figure 5). The interaction effect between the study group and measurement time was not statistically significant ($F(4, 242) = 0.368$, $p = .831$) (Table 2). Season had a significant effect on fatigue in the evening ($F(1, 120) = 8.942$, $p = .003 < .01$). Because of these seasonal effects, fatigue in the evening was also analyzed separately for the spring and fall samples. The analyses revealed no significant interaction effects between the study group and measurement time for either the spring data ($F(4, 126) = 0.960$, $p = .432$) or the fall data ($F(4, 108) = 0.382$, $p = .821$). Evening fatigue levels were generally higher during fall than during spring (Appendix).

Regarding hypothesis 2c, the mean levels of fatigue in the morning for each group ranged from 3.67 to 4.10 on a scale of 1 to 7 across the study period (SD's from 0.98 to 1.93, Figure 5). The interaction effect between the study group and measurement time was not statistically significant ($F(4, 264) = 0.508$, $p = .712$). Measurement time had a significant main effect for fatigue in the morning ($F(2, 264) = 3.161$, $p = .049 < .05$). Post-intervention morning fatigue levels were slightly higher than morning fatigue levels during the intervention for the exposure to nature group and the relaxation group (Figure 5).

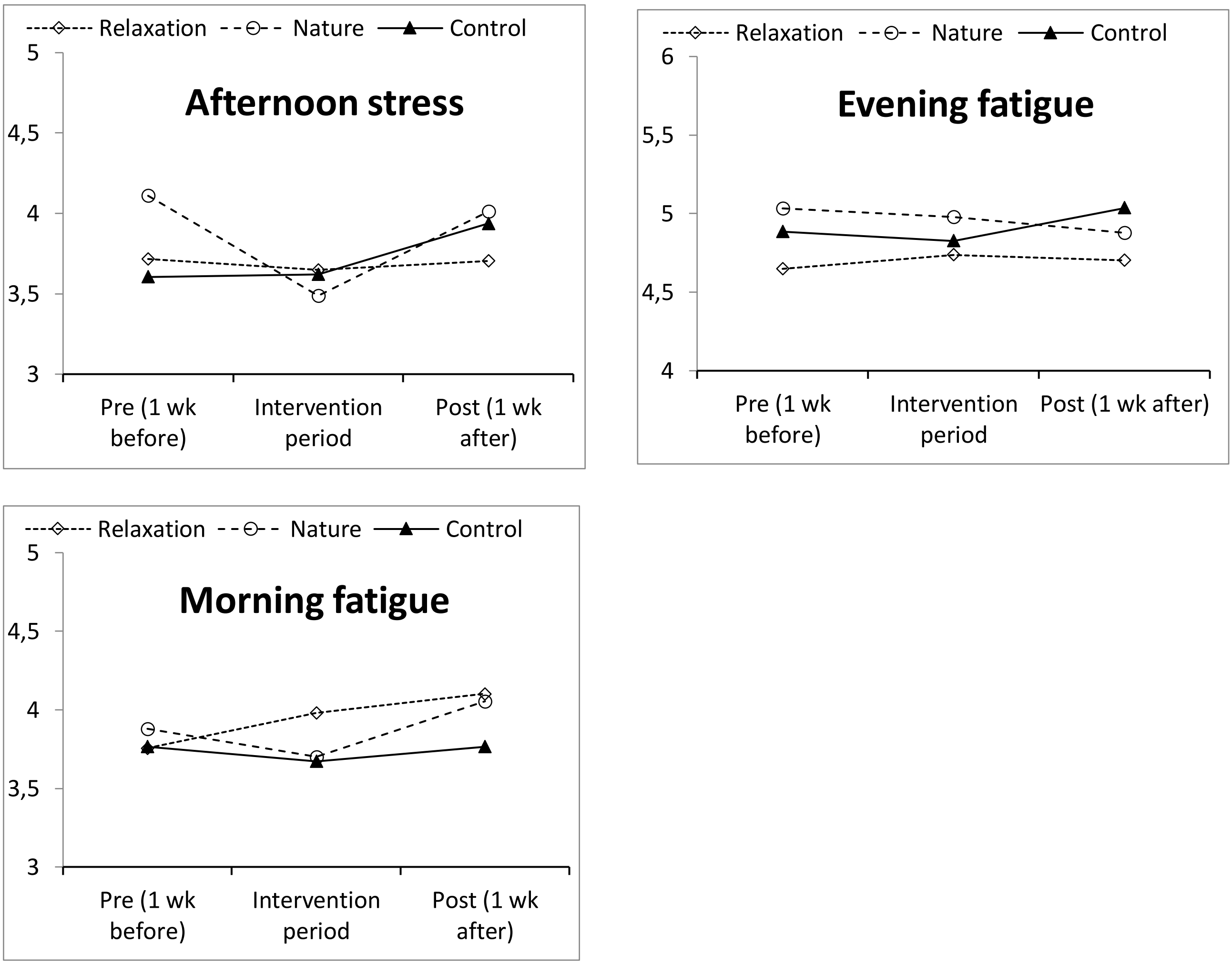

FIGURE 5. The group means for perceived stress in the afternoon and fatigue in the evening and in the morning before, during and after the intervention period (see Figure 1).

Overall, regarding research question 2, the study showed no significant interactions between the study group and measurement time (T_{1-3}) for the three subjective measures (afternoon stress, evening fatigue and morning fatigue). Participating in relaxation or exposure to nature interventions did not significantly affect stress or fatigue. Time effects and seasonal effects were observed for fatigue, especially the subjects' fatigue levels were generally higher during fall than during spring.

TABLE 2. Main and interaction effects of intervention group and measurement time (T_{1-3}) for cortisol measures, perceived stress and fatigue.

Measure	Group effect *F* values	Time effect *F* values	Group × time effect *F* values
CARi	0.690	0.552	0.646
CDD	3.739*	0.478	0.767
Evening cortisol	1.154	1.870	1.546
AUCg	1.167	0.707	1.650
Afternoon stress	0.308	0.928	1.110
Evening fatigue	0.788	1.353	0.368
Morning fatigue	0.403	3.161*	0.508

* $p < .05$.

The associations between cortisol measures, perceived stress and fatigue

Concerning research question 3, the partial correlations between cortisol variables and the subjective variables were examined (Table 3). The partial correlations ranged from -.270 to .099, and all of the significant correlations were negative. Cortisol in the evening had a marginally significant, negative correlation with fatigue in the evening (-.234 to -.244) across all three time points (week before the intervention, during the intervention weeks and week after the intervention). Thus, the higher a person's cortisol level was in the evening, the less fatigued he or she felt. CDD had a significant, negative correlation with fatigue in the evening and a marginally significant, negative correlation with stress in the afternoon in the week before the intervention, but no significant correlations during or after the intervention with either of the two variables. Thus, the more a person's cortisol level declined from 30 minutes after awakening to the evening in the week before the intervention, the more fatigued he or she felt in the evening and the more stressed he or she felt in the afternoon. AUCg had a marginally significant, negative correlation with fatigue in the evening during the intervention weeks. Thus, the more cortisol a person secreted during the intervention weeks, the less fatigued he or she felt in the evening. In half of the comparisons (cortisol level in the morning & fatigue in the morning, cortisol level 30 minutes after awakening & fatigue in the morning, CARi & fatigue in the morning, AUCg & stress in the afternoon), no significant correlations emerged on any of the time points (Table 3).

Overall, concerning research question 3, the only significant partial correlations found were negative, contrary to the hypotheses. The negative correlations were marginally significant between evening cortisol and evening fatigue before, during and after the intervention period. At least marginally significant correlations were also found between CDD and evening fatigue, and CDD and afternoon stress before the intervention, and between AUCg and evening fatigue during the intervention. The remaining 18 partial correlations did not reach a level of marginal significance (p <.10).

TABLE 3. Partial correlations between the transformed cortisol variables and the most time-related subjective measures.

Partial correlation	Pre-intervention	During intervention	Post-intervention
Cort_M & Morning fatigue	-.098	.099	.045
Cort_AR & Morning fatigue	-.097	.015	.067
Cort_E & Evening fatigue	-.243^	-.244^	-.234^
CARi & Morning fatigue	-.108	-.043	.072
CDD & Stress	-.222^	-.140	-.162
CDD & Evening fatigue	-.270*	-.171	-.194
AUCg & Stress	-.076	-.199	-.029
AUCg & Evening fatigue	-.128	-.215^	-.122

^ p <.10, * p <.05.
Cort_M = Cortisol level in the morning
Cort_AR = Cortisol level 30 minutes after awakening
Cort_E = Cortisol level in the evening

DISCUSSION

In this study, the effectiveness of two interventions, relaxation exercises and exposure to nature in the form of park walk which were implemented during lunch breaks, was examined on cortisol variables, perceived stress and fatigue. A total of 153 employees from seven different organizations participated in the study, either during spring or during fall 2014. The subjects in the relaxation group applied a self-practicable relaxation method, and the subjects in the exposure to nature group walked in a nearby park while paying attention to elements of nature. Both interventions lasted for 15 minutes during the lunch break, while the control group spent their lunch break as usual. The subjects in the intervention groups carried out their intervention on each working day's lunch break during a two-week intervention period (i.e. during 10 working days). Data on cortisol and subjective measures were gathered on Tuesdays and Thursdays during the intervention period, and also the week before the intervention and the week after (Figure 1).

Based on previous findings, I hypothesized that both the relaxation and exposure to nature interventions would have beneficial effects on cortisol secretion, and perceived afternoon stress and evening fatigue. Contrary to the hypotheses, no significant effects on cortisol measures – CARi, CDD, cortisol in the evening or AUCg were found for either of the intervention groups. Thus, it can be concluded that the interventions were in general not effective in affecting the cortisol functioning of the employees. The relaxation group had a slightly steeper CDD than the control group in the week before the intervention. Thus, in the week before the intervention, the relaxation group had in general a steeper decline in their cortisol levels towards the evening than the control group. For cortisol in the evening and AUCg, there was a small interaction effect of time and season. During spring, AUCg levels reflecting the day's total cortisol secretion seemed to be slightly lower and the evening cortisol values seemed to increase during and after the intervention for the relaxation group and for the control group, while during fall the AUCg values seemed to be slightly higher and the evening cortisol values seemed to decrease during and after the intervention for the exposure to nature group and for the control group (see Appendix for details).

There were also no statistically significant effects on perceived stress in the afternoon, fatigue in the evening or fatigue in the morning for either of the intervention groups, contrary to the hypotheses. Thus, the intervention did not notably decrease afternoon stress or morning/evening fatigue. Fatigue levels in the evening were consistently higher during fall than during spring. For morning fatigue, intervention levels for all groups (including control group) were slightly lower than post-intervention levels.

There are many possible factors which can explain why the intervention was in general ineffective in producing significant results on cortisol functioning. First, the effects of a 15-minute relaxation or exposure to nature intervention on cortisol secretion could be very short-lasting. Since cortisol was not measured right before or after the lunch break due to time management issues related to the study's field design, it was not possible to capture the most short-term effects. Second, a 10-day intervention period may simply be too short for a lunch-break intervention to start producing notable day-level effects on cortisol functioning. In a previous study by Krajewski et al. (2011), a reduced CAR was observed only 5-6 months after the start of the intervention period, and the only consistent improvements before then (e.g. one week after the start of the intervention) were found in post-lunchtime and bedtime cortisol measures. Thus, more long-lasting or intensive interventions may be needed to affect the diurnal cortisol measures, such as CAR and CDD. Third, psychological detachment is a vital component of recovery from work (Sonnentag & Fritz, 2007, 2015). A 15-minute lunch break intervention may be too short to improve psychological detachment, which could in turn aid physiological recovery (resulting in a lower CAR or a steeper CDD, for example), and also reduce stress and fatigue. Fourth, the rather small final sample size of the cortisol sample reduced statistical power of the analyses, making it more difficult to find significant results. Data cleaning with many people excluded could have also resulted in some selection bias, although this is unlikely since there were no significant differences in the characteristics between excluded participants and the final sample, and clear, well-established criteria were used in the cleaning process.

Contrary to the hypotheses, mostly negative correlations between the cortisol measures and subjective measures were observed. As low correlations are generally observed between physiological and subjective measures (Ganster, 2008), the correlations observed in this study fell in the expected range or were even higher than in many of the earlier studies (e.g. Chida & Steptoe, 2009). The clearest associations were found between cortisol in the evening and evening fatigue as well as CDD and evening fatigue (the latter only significant during pre-intervention measures). Higher fatigue in the evening was related to lower cortisol level in the evening and to steeper CDD. Low cortisol levels across the whole day reflect a deactivation of the HPA axis (McEwen, 1998). Thus, lower cortisol levels could be related to high fatigue in the evening through the weaker functioning of the HPA axis. A worker may have been very tense and highly activated during the day, trying to meet high work demands with high effort (Meijman & Mulder, 1998), and be deactivated and spiritless in the evening (having low evening cortisol and high fatigue). Since a moderate level of HPA axis activation is required for the body to sustain well-being and keep the cognitive processes going, this physiological status of deactivation could be an early marker of burnout and other health problems (such as troubles in falling asleep or depression). This connection is therefore an important finding of this study.

Other significant correlations are harder to explain, but they were (marginally) significant in only one of the three time points. A very steep CDD could indicate that a person has a too high cortisol awakening response, possibly when he/she expects high stress (Lovell et al., 2011), which would be then correlated with more perceived stress in the afternoon and more perceived fatigue in the evening. However, it would be against expectations if a steep CDD would be associated with more stress and fatigue in workers which show a normal stress response (instead of a markedly high one), since a steady decline of cortisol is needed for the HPA axis to recover from daily strain. There have also been negative or mixed effects of a steep CDD on subjective health variables in some of the previous studies (Karlson et al., 2011; Steptoe et al., 2000). Still, most studies have shown beneficial effects related to a steep CDD (e.g. Harris et al., 2007; Liao et al., 2013; Lovell et al., 2011; Powell et al., 2013): For instance, a steep CDD has been related to low effort-reward imbalance (Liao et al., 2013) and high decision authority (Harris et al., 2007). It seems that the connections between subjective well-being indicators and salivary cortisol measures are rather complex, with many possible mediating or moderating factors such as mood (Kudielka et al., 2012) or perseverative cognition (Brosschot et al., 2006). More research is needed to understand these relations better.

Season (spring/fall) had an effect on some of the outcome measures. Evening fatigue was higher during fall than during spring, and AUCg levels were, correspondingly, slightly higher in fall. During spring, people may spend more time outdoors and look forward to their summer holidays, lowering their fatigue. Luminous intensity affects cortisol secretion through changes in the body's circadian system (Persson et al., 2008), which could explain the slightly lowered AUCg in spring. Seasonal effects were found in this study also on evening cortisol, although they were more inconsistent and thus difficult to explain. Overall, season seems to play a role in fatigue in the evening, cortisol in the evening and the total cortisol output (AUCg) across the day.

Strengths and limitations

Strengths of this study include its randomized longitudinal design with two intervention groups and a control group, which enabled making inferences about the intervention effects in different time points and also enabled comparing the effects of two interventions to one another. The intervention period lasted for two weeks and measurements were also taken in the week before and in the week after (Figure 1), which is quite an extensive setup for a field study. The study's reliability was improved by having two measurement days for each study week for the cortisol and subjective measures, instead of a single one per week, and by using time-sensitive diary measures with the help of SMS's sent to the participants. The subjects worked in their workplaces as usual during the study, and the interventions were implemented during normal lunch breaks. Thus, the study had a field design with more ecological validity than it would have had if, for example, cortisol measurements had been taken in a laboratory after a stress test or if the interventions had disrupted the workflow of a typical working day.

While the study has many strengths, it also has its limitations. The final cortisol sample was relatively small because of the conservative approach taken in data cleaning and because of the case-exclusive nature of ANOVA's dealing with missing data. Only three cortisol measures across the day were used, which is the bare minimum of measurement times per day that enables analyses of diurnal cortisol activity (Kudielka et al., 2012). A design with more cortisol measurements per day would have allowed more subtle analyses of the derived cortisol measures, but would also have been more costly and put more strain on the subjects who already took a large number of samples and filled in plenty of diary information during the study. The classification criteria to separate non-respondents from respondents are always somewhat arbitrary, since no generally accepted guidelines exist on how the separation process should be performed. A separation criterion different from the 2,5 nmol/l used by Wüst et al. (2000) might have produced slightly different results. Furthermore, this sample consisted mostly of female knowledge workers. Future research could be conducted in different kinds of working populations, such as those that generally have more men, employees doing mainly physical work or with people from different ethnic cultures. There are many factors affecting cortisol secretion which were not possible to take into account all at once. For example, daily psychosocial job demands and resources, such as workload and decision authority, may have had a role but were not controlled for in this study. Nevertheless, it can be speculated that they should have affected employees' self-reports of stress and fatigue. Since these were measured by one-item scales their reliability cannot be evaluated.

Recommendations for future studies and theoretical considerations

For future studies, lunch break interventions with longer intervention periods (see Krajewski et al., 2011) or more intensive intervention designs (such as a 30-minute intervention implemented in the middle of the working day or many short intervention breaks during the working day) should be applied. It seems that a two-week intervention period is too short for a 15-minute lunch break intervention to produce effects in cortisol measures, at least for park walking and relaxation. The relative benefits of different types of interventions (such as relaxation, cognitive-behavioral, exposure to nature or multimodal) could be explored more by including more than one intervention group in the design, as was done in this study, although that would demand a large number of subjects in the sample. Future intervention studies which use cortisol or fatigue as outcome measures could also benefit from taking the seasonal time of the study into account, since slightly different intervention effects could be observed in different seasons, even when the same intervention is implemented on all seasons. The negative correlation findings in this study warrant further exploring of the relations of CDD, evening cortisol and AUCg and subjective measures such as stress and fatigue. The decline of cortisol during the day and total cortisol output may have different effects on stress and fatigue in special groups, such as burnout patients or those with acute effort-recovery imbalance or extreme levels of stress. Thus, in future research different subgroup analyses would be needed.

Intervention studies investigating the effects of work and organizational interventions on physiological variables such as cortisol or blood pressure are still relatively scarce. Subjective measures might be generally more reactive to these interventions than physiological variables. If a change in a subjective variable (such as stress) becomes clear and more permanent, a corresponding change in a physiological variable (such as CDD) could follow later with a delay. Alternatively, it might be overall difficult to create changes on a physiological level by applying work and organizational interventions. Bowler et al. (2010), for example, found no significant effects in cortisol or blood pressure in their meta-analysis concerning exposure to nature.

Conclusion

In summary, the two lunch break interventions (relaxation and exposure to nature), implemented during 10 consecutive working days for 15 minutes per day, did not produce significant changes in cortisol, perceived stress or fatigue. Power issue may have affected the results, so that the observed trends did not reach a level of significance. Longer or more intensive relaxation or exposure to nature interventions are needed to affect cortisol functioning.

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APPENDIX: Seasonal differences in cortisol and subjective well-being

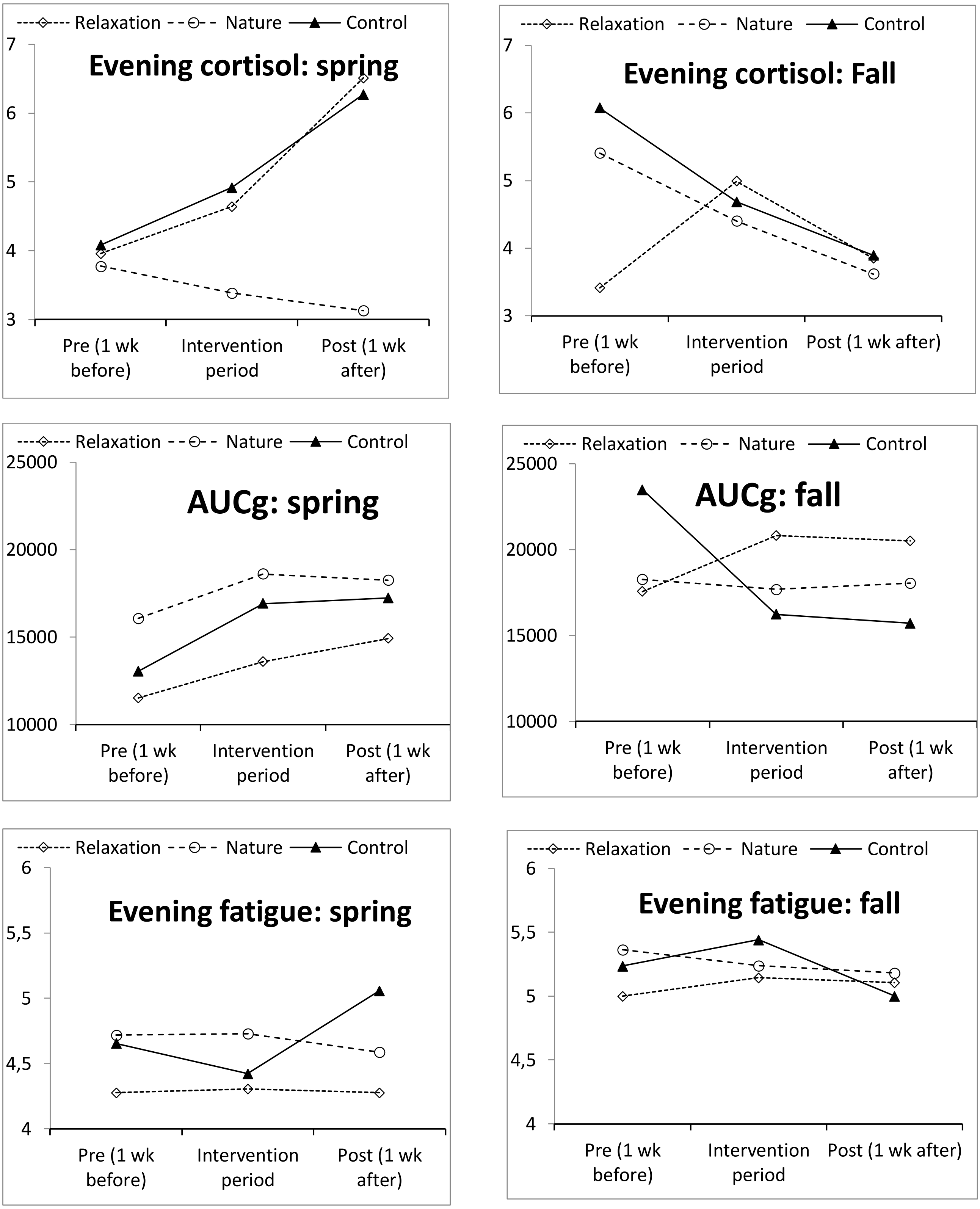

FIGURE 1. The group means of cortisol in the evening, AUCg and perceived fatigue in the evening for the spring and fall samples before, during and after the intervention period (see Figure 1). Units in nmol/l for evening cortisol and in nmol/(l*min) for AUCg.